throughout the drawings and the following detailed description to refer to the same or like parts.

[0023] In the interest of clarity, not all of the routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another.

[0024] A plasma haptic device, in one embodiment, generates haptic feedback over a touch surface using plasma actuation. A device includes a touch surface, plasma, and a substrate. In one embodiment, the touch surface, which can be made of flexible and/or deformable materials, is capable of sensing one or more events. The substrate is situated adjacent to the touch surface with a separation gap, which physically separates the substrate from the touch surface. The substrate provides haptic feedback in response to the event(s). The plasma is capable of accumulating at one or more pockets located in the separation gap, and configured to facilitate the haptic feedback via energy transfer.

[0025] FIG. **1**(*a*) shows a three-dimensional (3D) diagram illustrating a haptic flexible structure **100** using a haptic substrate and a flexible surface in accordance with one embodiment of the present invention. Flexible structure **100** includes a flexible surface layer **102**, a haptic substrate **104**, and a deforming mechanism **106**. In one embodiment, flexible structure **100** is an article of haptic fabric or cloth capable of changing patterns in response to the haptic feedback. It should be further noted that the underlying concept of the exemplary embodiment of the present invention would not change if one or more blocks (circuits or layers) were added to or removed from structure **100**.

[0026] Flexible surface layer **102**, in one instance, is made of soft and/or elastic materials such as silicone rubber, which is also known as polysiloxane. A function of the flexible surface layer **102** is to change its surface shape or texture upon contact with the physical pattern of haptic substrate **104**. The physical pattern of haptic substrate **104** is variable as one or more of the local features **110-124** can be raised or lowered to present features to affect the surface of the flexible surface layer **102** upon contact. Once the physical pattern of haptic substrate **104** is determined, the texture of flexible surface layer **102** can change to confirm its surface texture to the physical pattern of haptic substrate **104**. It should be noted that the deformation of flexible surface layer **102** from one texture to another can be controlled by deforming mechanism **106**. For example, when deforming mechanism **106** is not activated, flexible surface layer **102** maintains its smooth configuration floating or sitting over haptic substrate **104**. The surface configuration of flexible surface layer **102**, however, deforms or changes from a smooth configuration to a coarse configuration when deforming mechanism **106** is activated. Haptic substrate **104** is subsequently in contact with flexible surface layer **102** so as to generate a similar pattern on the top surface of flexible surface layer **102**.

[0027] Alternatively, flexible surface layer **102** is a flexible touch sensitive surface, which is capable of accepting user inputs. The flexible touch sensitive surface can be divided into multiple regions wherein each region of the flexible touch sensitive surface can accept an input when the region is being touched or depressed by a finger. In one embodiment, the flexible touch sensitive surface includes a sensor, which is capable of detecting a nearby finger and waking up or turning on the device. Flexible surface layer **102** may also include a flexible display, which is capable of deforming together with flexible surface layer **102**. It should be noted that various flexible display technologies can be used to manufacture flexible displays, such as organic light-emitting diode (OLED), organic, or polymer TFT (Thin Film Transistor).

[0028] Haptic substrate **104** is a surface reconfigurable haptic device capable of changing its surface pattern in response to one or more pattern activating signals. Haptic substrate **104** can also be referred to as a haptic mechanism, a haptic layer, a tactile element, and the like. Haptic substrate **104**, in one embodiment, includes multiple tactile or haptic regions **110-124**, wherein each region can be independently controlled and activated. Since each tactile region can be independently activated, a unique surface pattern of haptic substrate **104** can be composed in response to the pattern activating signals. In another embodiment, every tactile region is further divided into multiple haptic bits wherein each bit can be independently excited or activated or deactivated.

[0029] Haptic substrate **104**, or a haptic mechanism, in one embodiment, is operable to provide haptic feedback in response to an activating command or signal. Haptic substrate **104** provides multiple tactile or haptic feedbacks wherein one tactile feedback is used for surface deformation, while another tactile feedback is used for input confirmation. Input confirmation is a haptic feedback informing a user about a selected input. In one embodiment, haptic substrate **104** is flexible and soft. For example, haptic mechanism **104** can be implemented by various techniques including vibration, vertical displacement, lateral displacement, push/pull technique, air/fluid pockets, local deformation of materials, resonant mechanical elements, piezoelectric materials, micro-electro-mechanical systems ("MEMS") elements, thermal fluid pockets, MEMS pumps, variable porosity membranes, laminar flow modulation, or the like.

[0030] Haptic substrate **104**, in one embodiment, is constructed by flexible, semi-flexible, semi-rigid, or rigid materials. In one embodiment, haptic substrate should be more rigid than flexible surface **102** thereby the surface texture of flexible surface **102** can confirm to the surface pattern of haptic substrate **104**. Haptic substrate **104**, for example, includes one or more actuators, which can be constructed from fibers (or nanotubes) of electroactive polymers ("EAP"), piezoelectric elements, fiber of shape memory alloys ("SMAs") or the like. EAP, also known as biological muscles or artificial muscles, is capable of changing its shape in response to an application of voltage. The physical shape of an EAP may be deformed when it sustains large force. EAP may be constructed from electrostrictive polymers, dielectric elastomers, conducting polymers, ionic polymer metal composites, responsive gels, bucky gel actuators, or a combination of the above-mentioned EAP materials.

[0031] SMA, also known as memory metal, is another type of material which can be used to construct haptic substrate **104**. SMA may be made of copper-zinc-aluminum, copper-aluminum-nickel, nickel-titanium alloys, or a combination of copper-zinc-aluminum, copper-aluminum-nickel, and/or nickel-titanium alloys. A characteristic of SMA is that when its original shape is deformed, it regains its original shape in accordance with the ambient temperature and/or surrounding environment. It should be noted that the present embodiment